NORTH WEBSTER STORM DRAIN
ENGINEERING FEASIBILITY STUDY

KOSCIUSKO COUNTY, INDIANA

October 29, 2002

Prepared For:

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EXECUTIVE SUMMARY

The Lake Webster Conservation Association (LWCA) received an Indiana Department of Natural Resources (IDNR) Lake and River Enhancement (LARE) grant to complete an engineering feasibility study targeted at reducing storm drain pollution which was identified as a problem during the Lake Webster/Backwaters Area Diagnostic Study in 2000. LWCA hired the J.F. New & Associates, Inc. (JFNew) team to conduct the study. The goal of the study was to determine the feasibility of retrofitting the storm drains regulated by the Town of North Webster with pollutant removal devices. The project involved mapping and analysis of existing drains where sources of pollution may exist, suggesting maintenance and technology that may be used to address pollution, and examining the feasibility of project design and construction. To be deemed feasible, a project and project sites needed to: be physically accessible, receive regulatory agency support, be acceptable to property owners, show no evidence that upon implementation nearby wetlands, lakes, and streams will be adversely impacted, be physically and socially constructible, and be environmentally, economically and socially justifiable.

This study examined 18 storm drain networks within North Webster town limits that conduct storm flow runoff directly from town and residential areas into Lake Webster. Town maps were updated and revised to include all existing drains and current hydrology. When the feasibility study was initiated, the initial conceptual idea was to investigate fitting two or three of the drains with "swirl collector style" Continuous Deflective Separation (CDS) systems. Upon inspection, JFNew and LWCA decided that a proper storm drain maintenance program coupled with a less expensive filtration technology known by the trade name Streamguard will help the town and the LWCA reduce pollution carried to the lake with storm water.

During the feasibility study, storm drains were prioritized based on several factors including estimations of the severity of pollutant loading. Prioritization will allow the town and the LWCA to treat higher priority drains first and lower priority drains as resources will allow. Retrofitting all drains with Streamguard filtration technology will cost about $10,000 per year, while treating only high priority drains will cost $5,000 per year. In addition to a prioritization, the feasibility study revealed some other important issues for storm water management around Lake Webster including: 1) the recognition that maintenance has not been occurring in the past around the lake and is very important to prevent pollution to the lake; 2) the provision of edits and additions to the town map of existing drains that were previously not recognized; and 3) the need for a LWCA representative to regularly attend Town Council meetings in order to achieve better long-term communication.

ACKNOWLEDGMENTS

This feasibility study was performed with funding from the Indiana Department of Natural Resources Division of Soil Conservation and the Webster Lake Conservation Association. J.F. New & Associates, Inc. documented available historical information, assessed project feasibility and environmental impact, and forwarded opinions of probable cost for retrofitting existing storm drains regulated by the Town of North Webster with pollutant removal devices as identified during the 2000 Lake Webster/Backwaters Area Diagnostic Study. Dawn and Don Meyer of the Webster Lake Conservation Association provided initiative and assistance in getting this study completed. Kay Andrews president of the North Webster Town Council, and Town Council members Ken Wagner and Jeff Morgan were helpful in allowing presentation of the study results at a Town Council meeting and have indicated support for arranging for a maintenance contract with Severn Trent Services. Dennis Reafsnyder and Thomas Miller of Severn Trent are currently in charge of utilities for the town and were receptive to maintenance schedule adoption. Chris France with the North Webster Sewage Treatment Plant graciously processed project chemical samples at no charge to the Lake Webster Conservation Association or to the project. Thanks to the Lake Webster Conservation Association members for support. Authors of and significant contributor to this report include Cornelia Sawatzky and John Richardson with J.F. New & Associates, Inc. and Lynn Stevens with the Tippecanoe Environmental Lake and Watershed Foundation (TELWF). TELWF has been instrumental in sponsoring and organizing watershed-level work in the Upper Tippecanoe River Watershed.

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1.0 INTRODUCTION

1.1 BACKGROUND

The Webster Lake Conservation Association (WLCA) has recognized that lake quality is directly connected to activities in the watershed that includes the incorporated Town of North Webster. Sampling in the past categorizes Webster Lake as eutrophic meaning that the lake is extremely fertile and susceptible to nuisance duck week population growth, algae blooms, and re-invasion by Eurasian water milfoil. In 1999, the WLCA received a grant from the Indiana Department of Natural Resources (IDNR) Lake and River Enhancement (LARE) Program to conduct a lake and watershed diagnostic study in order to document existing conditions in Webster Lake and the Backwaters and to diagnose potential pollutant sources to the lake. J.F. New & Associates, Inc. (JFNew) conducted the 2000 Webster Lake/Backwaters Area Diagnostic Study. According to the study, 85% of phosphorus loading to the lake comes from the watershed, and "regulated city drains, especially those on the northwest corner of the lake, carried organic and inorganic debris to the lake…during several storm events" (J.F. New & Associates, Inc., Webster Lake/Backwaters Area Diagnostic Study, 2000). The study suggests that the phosphorus load to Webster Lake would need to be reduced by about 32% to achieve an in-lake phosphorus concentration that would slow eutrophication. Final study recommendations included retrofitting of city regulated storm drains with pollutant removal devices and developing an inspection and maintenance plan for these devices. In 2001, the WLCA again received a grant to determine the feasibility of retrofitting the storm drains regulated by the Town of North Webster with pollutant removal devices. The purpose of the current study is to determine design and installation feasibility for storm drain retrofitting and to recommend an inspection and maintenance plan for the pollutant removal devices and the drains themselves.

1.2 SCOPE OF STUDY

The scope of the study included the watershed area directly west and southwest of Webster Lake within the incorporated city limits of North Webster in Kosciusko County (Figure 1). (Please note that the most westward street marked on the figure as Center Street is actually Albert Eckert Drive. The other street marked as Center Street is Center Street West. Finally, the street marked as Albert Eckert Drive is actually Center Street East.) The diagnostic study specifically targeted town-regulated drains since they drain runoff from heavily used roadways and urban areas. JFNew conducted field surveys to update and revise town drainage maps, observe the current conditions of the drains and their drop structures, determine feasibility of various retrofitting technology options, and prioritize drain networks for treatment. Signatures of support for maintenance and retrofitting (if deemed necessary in the future) were obtained from the North Webster Town Council and their utilities contractor, Severn Trent Services (STS).

1.3 GOALS AND OBJECTIVES

The goal of this study was to examine the feasibility of retrofitting town-regulated storm drains with pollutant filtration devices. To be deemed feasible, the technology needed to be: 1) installable; 2) acceptable to and permitted by the North Webster Town Council and their utilities contractor, STS; 3) economically justifiable; and 4) maintainable. The feasibility study attempted to ensure project success by investigating all avenues that could potentially cause project failure and satisfy any concerns raised.

J.F. New & Associates, Inc.
JFNA #98-04-25/02

North Webster Storm Drain Engineering Feasibility Study
Kosciusko County, Indiana

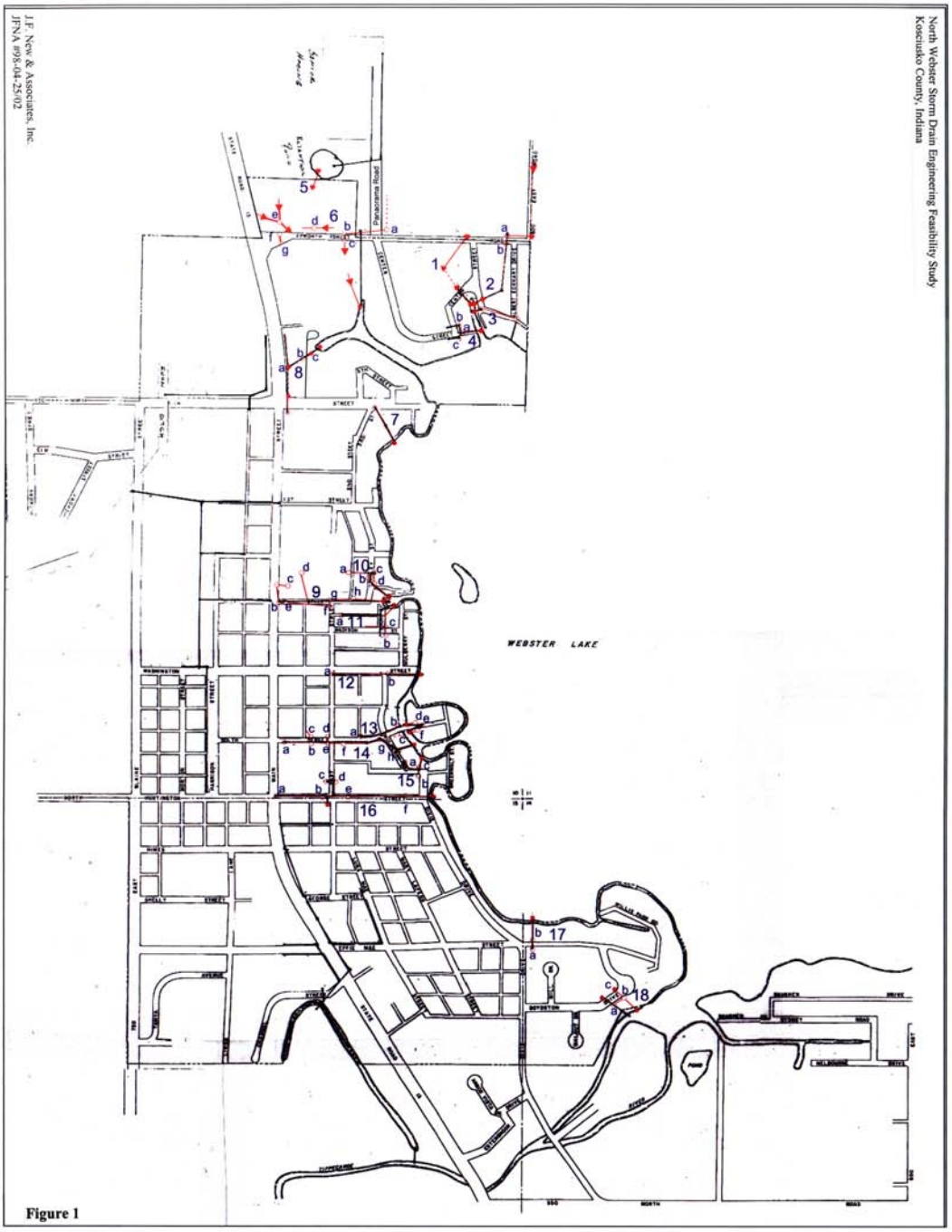

Figure 1

LEGEND

- STORM DRAIN
- CULVERT/ OPEN PIPE
- OPEN DRAIN
- CLOSED DRAIN

TOWN OF
NORTH WEBSTER, INDIANA
STREET MAP

0 600
GRAPHIC SCALE IN FEET

October 29, 2002

2.0 DESCRIPTION OF STUDY AREA

2.1 LOCATION

The Webster Lake Watershed (14-digit hydrologic unit codes 05120106010-010, -020, -030, and -040) encompasses 31,459 acres (12,736 ha) in northeastern Kosciusko County, Indiana (Figure 2). The watershed includes the headwaters of the Upper Tippecanoe River, which conducts water to the Wabash River, a tributary of the Ohio River in southwestern Indiana. Four main drainages transport water from the watershed to Webster Lake (Figure 3). The main inlet is the Tippecanoe River which drains most of the watershed. Two smaller, open channel inlets on the north-northwest side of the lake near Center Street West and Albert Eckert Drive also conduct water to the lake from agricultural and residential areas. This feasibility study is primarily concerned with the urbanized area of the watershed located at its western edge (Figure 1). Storm water drain infrastructure beneath roadways and buildings maintained by the Town of North Webster drains most of this area directly to the lake.

2.2 GEOLOGIC HISTORY AND TOPOGRAPHY

Webster Lake formed during the most recent glacial retreat of the Pleistocene era. The advance and retreat of the Saginaw Lobe of a later Wisconsinian Age glacier as well as the deposits left by the lobe shaped much of the landscape in northeastern Indiana (Homoya et al., 1985). The Saginaw Lobe retreat left a broad, flat to rolling glaciated plain which has been classified as the Northern Indiana Till Plain Ecoregion (Omernik and Gallant, 1988). Glacial till and outwash, sandy gravelly beach ridges, flat belts of morainal hills, and bog kettle depressions characterize this ecoregion (Simon, 1997). The topography of the Webster Lake Watershed is typical of much of Kosciusko County and was determined to a large extent by glaciation. Topography is gently rolling in the area. The Town of North Webster is located 20 feet above the lake at a relatively steep slope. In fact, State Road 13 which passes through downtown forms the western watershed boundary as storm water on the west side of the road is passed to Kuhn Ditch and storm water on the east side flows to Webster Lake. This results in significant storm water runoff inputs to the lake from impervious surfaces and urbanized areas. It is important to note here that Webster Lake itself is a product of altered hydrology. The lake was formed in the mid to late 1800s when a dam was constructed on the Tippecanoe River, flooding five small, natural lake basins to form the 585-acre (237-ha) impoundment.

2.3 LAND USE

The Webster Lake Watershed lies within the Northern Lake Natural Area (Homoya et al., 1985). Natural communities found in this region prior to European settlement included bogs, fens, marshes, prairies, sedge meadows, swamps, seep springs, lakes, and deciduous forests. Like much of the landscape in Kosciusko County, a large portion of the Webster Lake Watershed was converted to agricultural land uses. Today, about 76% of the watershed is utilized for agricultural purposes including row crop and pasture (Figure 4). Corn and soybeans are the major crops grown on this land. An additional land use change involves residential and commercial development of the lake's northwestern and western shorelines which currently compose about 2% of the lake's immediate watershed. (For the purposes of this report, the immediate watershed is considered the 14-digit hydrologic unit code (05120106010040) immediately surrounding the lake.) Wetlands and open water account for approximately 12% of

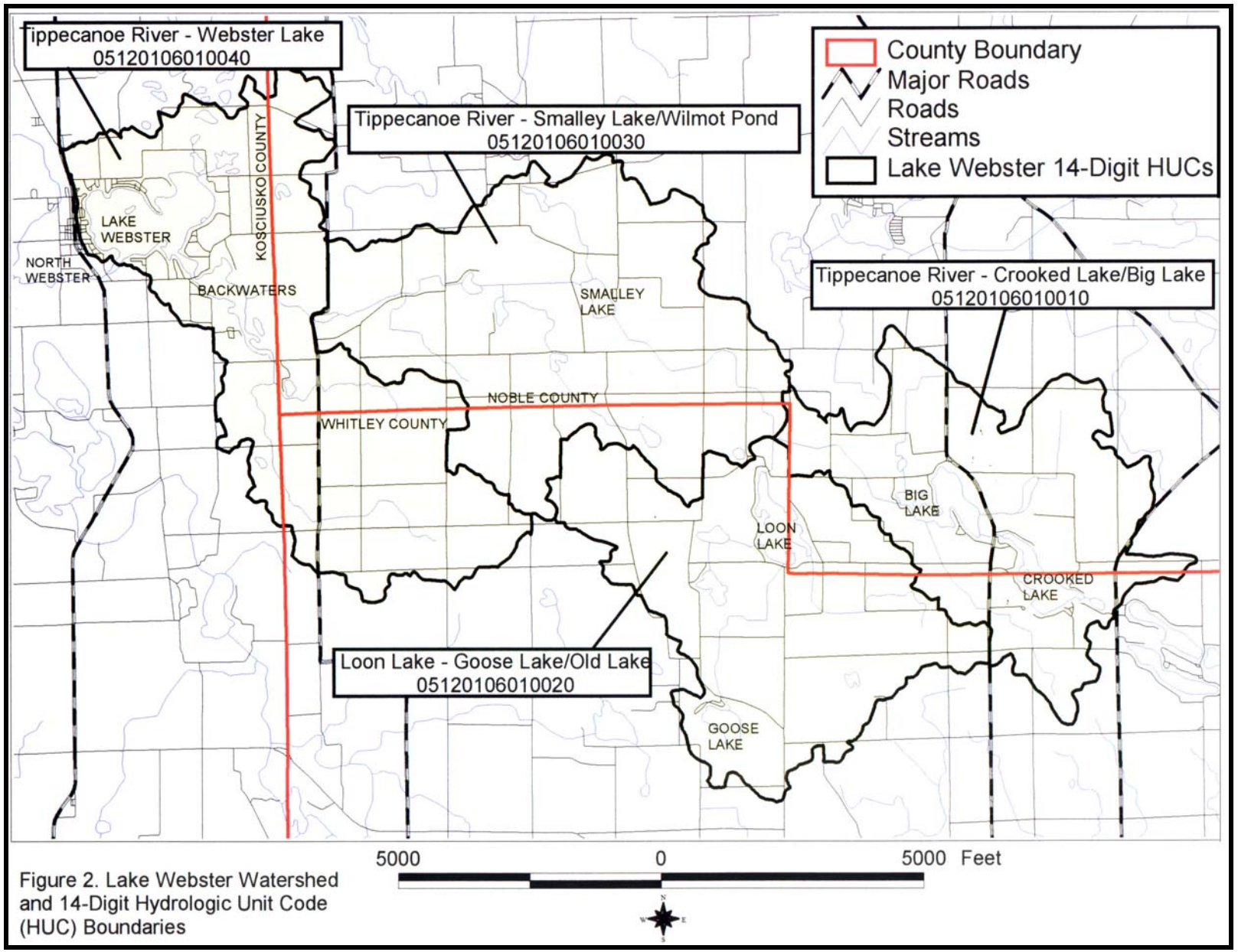

Figure 2. Lake Webster Watershed and 14-Digit Hydrologic Unit Code (HUC) Boundaries

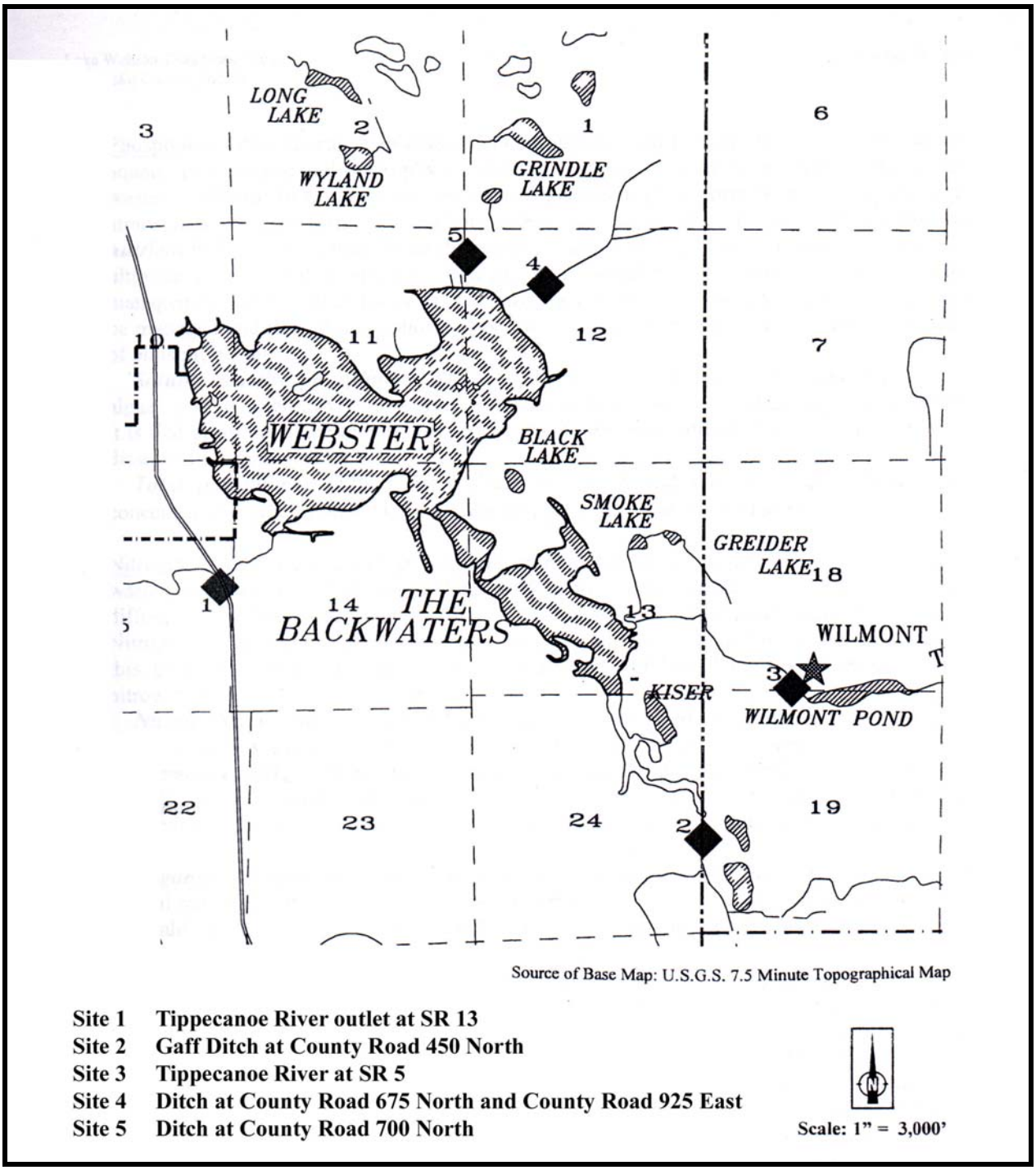

FIGURE 3. Drainage inlets to Webster Lake.

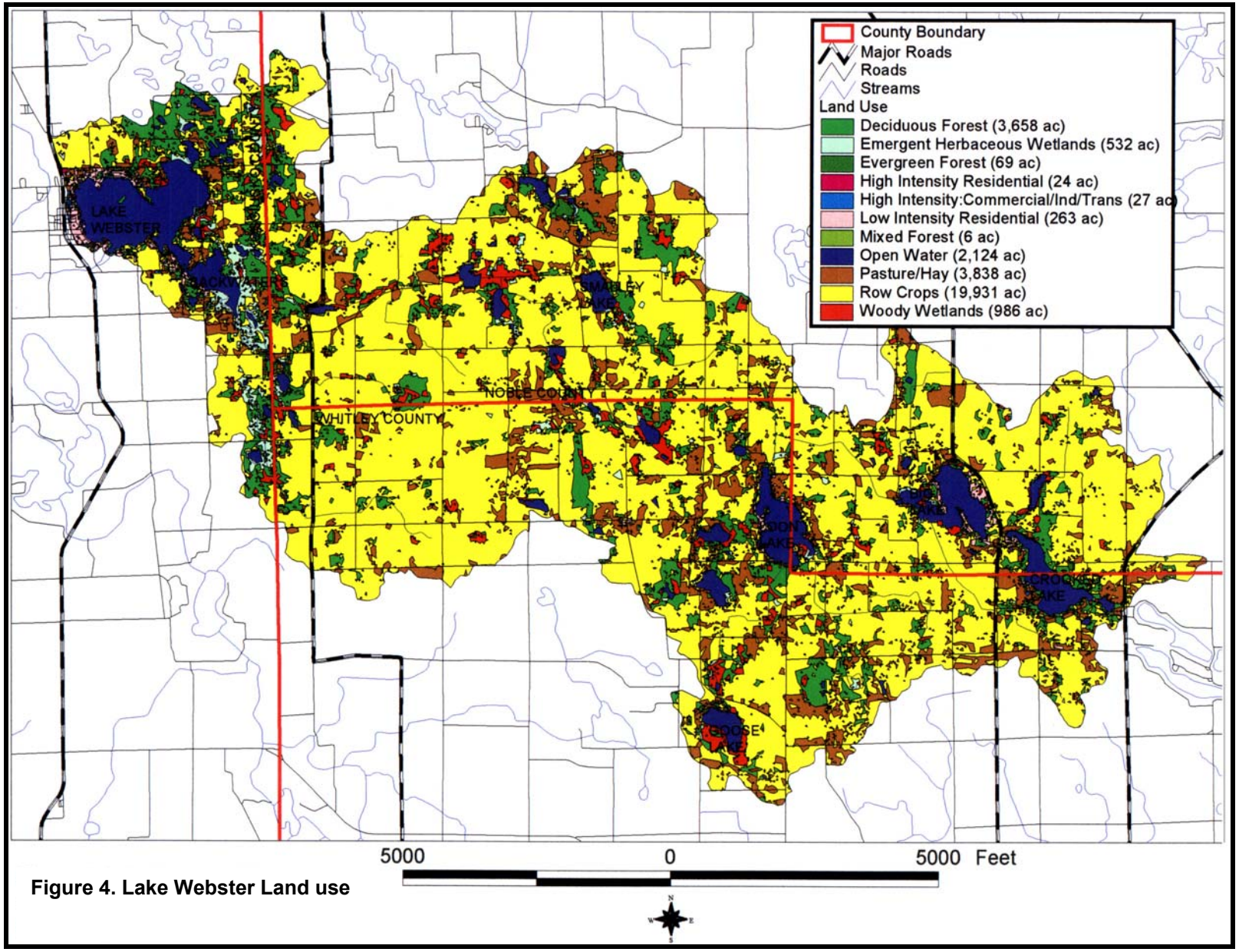

Figure 4. Lake Webster Land use

the entire watershed. Table 1 provides land use acreages for the Webster Lake Watershed based on the USGS/EROS Indiana Land Cover Data Set, Version 98-12.

TABLE 1. Land use in the Webster Lake Watershed.

Land Use	Acreage
Deciduous forest	3,658
Emergent herbaceous wetland	532
Evergreen forest	69
High intensity residential	24
High intensity commercial	27
Low intensity residential	263
Mixed forest	6
Open water	2,124
Pasture/hay	3,838
Row crop	19,931
Woody wetlands	986
TOTAL	**31,458**

2.4 EXISTING AND PLANNED BMPS

Existing Best Management Practices (BMPs) in the Webster Lake Watershed include agricultural practices like the Natural Resources Conservation Service (NRCS) storm water basin and grassed waterway project recently constructed in the lake's immediate watershed on the northwestern side. The IDNR and the Tippecanoe Environmental Lake and Watershed Foundation (TELWF) also recently worked with the landowner at County Roads 1050 W and 275 E to fence cattle away from the Tippecanoe River. Plans for additional projects are numerous and include those listed in the Upper Tippecanoe River Watershed Management Plan (WMP) for each of the subwatersheds. With a completed WMP, §319 money is expected to be available for project implementation. The WMP identifies potential project sites in three of the four Webster Lake Subwatersheds including the Tippecanoe River-Webster Lake, the Loon Lake-Goose Lake/Old Lake, and the Tippecanoe River-Crooked Lake/Big Lake Subwatersheds. In 2003, an IDNR LARE diagnostic study will be conducted in the Tippecanoe River-Smalley Lake/Wilmot Pond Subwatershed to identify BMPs that may be possible in that area. The WMP also includes BMP recommendations developed during an IDNR preliminary assessment of Big Lake in 1995. In the Tippecanoe River-Crooked Lake/Big Lake Subwatershed, the Crooked Lake Association is currently working on several design-build projects with funding from LARE to install detention basins, intercept tile drains, and incorporate bank stabilization practices. A camp located on the shoreline of Webster Lake is currently considering the feasibility of bioengineering to prevent bank erosion. The BMPs proposed during this current study address one of the identified action items for the Tippecanoe River-Webster Lake Subwatershed listed in the WMP (TELWF, 2002).

2.5 PRIOR STUDIES

Table 2 documents prior studies conducted in Webster Lake and its watershed. Many of the historical studies focused on documenting and managing Webster Lake fisheries and in-lake water quality. More recently studies have focused on watershed management with the

recognition that activities in the catchment of the lake affect water quality in the lake. The 2000 diagnostic study was the first to address watershed management of the areas draining into Webster Lake. The purpose of the diagnostic study was to: 1) describe conditions and trends in the lakes and the watershed; 2) identify potential problems; and 3) make prioritized recommendations addressing these problems.

TABLE 2. Current and prior studies conducted in the Webster Lake Watershed.

Year	Entity	Topic	Study
1973	USEPA	Water Quality	National Eutrophication Survey Report on Webster Lake
1976	IDNR, DFW	Fisheries	Webster Lake Fish Management Report*
1985	IDNR, DFW	Fisheries	Webster Lake Fish Management Report
1987	IDNR, DFW	Fisheries	Webster Lake Creel Survey
1987	ILNHS; IDNR	Mussels	Survey of Mussels in the Lower Wabash and Tippecanoe Rivers
1989	IDNR, DFW	Fisheries	Webster Lake Fish Population Survey
1989	KLPDC; IDNR, DSC	Water Quality	Preliminary Investigation of the Lakes of Kosciusko County
1990	IDNR, DFW	Fisheries	Webster Lake Creel Survey
1990	PCES	Watershed Management	Water Quality Plan for the Upper Tippecanoe River Watershed
1991	IDEM, CLP	Water Quality	Indiana Clean Lakes Assessment
1991	IDNR, DFW	Fisheries	Abundance, Angler Utilization, and Impacts of Muskellunge at Webster Lake
1992	IDNR; F.X. Browne	Watershed Management	Feasibility Studies of Loon Lake and Goose Lake
1993	IDNR; USFWS	Mussels	Mussel Habitat Stability and Impact Analysis of the Tippecanoe River
1993	IDNR, DSC; T. Crisman	Watershed Management	Assessment of Watershed-Lake Interactions Influencing Cultural Eutrophication of Crooked Lake
1994	IDEM, CLP	Water Quality	Indiana Clean Lakes Assessment
1995	USACOE	Water Quality/ Quantity	Upper Tippecanoe River Basin, Kosciusko County Interim Reconnaissance Report
1995	IDNR, DFW	Fisheries	Webster Lake Fish Management Report
1995	IDNR, DSC	Water Quality	Preliminary Assessment of Big Lake
1995	IDEM, IVMP	Water Quality	Seasonal Secchi Disk Monitoring of Webster Lake
1997 to current	IDEM, IVMP	Water Quality	Seasonal Secchi Disk Monitoring of Webster Lake
1998	IDEM, CLP	Water Quality	Indiana Clean Lake Program
1998	IDNR, DFW	Fisheries	Webster Lake Creel Survey
1998	IDNR, DFW	Mussels	Natural Lakes Mussel Survey
1999	IDNR, DFW	Fisheries	Muskellunge Population Characteristics at Webster Lake
2000	IDNR, DSC;	Watershed	Webster Lake/Backwaters Area Diagnostic Study

	JFNew	Management	
2001	IDEM, OWM	Watershed Management	Tippecanoe River Watershed Restoration Action Strategy
2001	TNC	Watershed Management	Tippecanoe River Project Strategic Plan
2002	TELWF; JFNew	Watershed Management	Upper Tippecanoe River Watershed Management Plan
2002	IDNR, DSC; SePro/Aquatic Control	Aquatic Plant Management	Aquatic Plant Management Study and Plan
2002	IDNR, DSC; JFNew	Watershed Management	Webster Lake Storm Drain Feasibility Study

IDEM, OWM = Indiana Department of Environmental Management, Office of Water Management
IDEM, CLP = Indiana Department of Environmental Management, Clean Lakes Program
IDNR, DFW = Indiana Department of Natural Resources, Division of Fish and Wildlife
IDNR, DSC = Indiana Department of Natural Resources, Division of Soil Conservation
ILNHS = Illinois Natural History Survey
IDEM, IVMP = Indiana Volunteer Monitoring Program
JFNew = J.F. New & Associates, Inc.
KLPDC = Kosciusko Lake Preservation and Development Council
PCES = Purdue Cooperative Extension Service
TNC = The Nature Conservancy
USACOE = United States Army Corps of Engineers
USEPA = United States Environmental Protection Agency
USFWS = United States Fish and Wildlife Service
* It is assumed that the IDNR DFW has surveyed other lakes in the Webster Lake Watershed, but these studies are not included in the above list.

The following recommendations were part of the 2000 Webster Lake/Backwaters Area Diagnostic Study: 1) designate a person or committee to work with the Soil and Water Conservation District (SWCD) to implement best management practices (BMPs) in the entire watershed; 2) construct a filter or wetland on a critical property to the northwest of the lake; 3) work with a landowner on a critical property to fence cattle away from the Tippecanoe River; *4) retrofit 11 city-regulated storm drains with pollutant removal devices and develop an inspection and maintenance plan for these devices;* 5) designate a person to work with the Whitley County Highway Department to stabilize bridge abutments in a critical area; 6) dredge select areas where sediment has built up; 7) consider the feasibility of spring muskellunge stocking; 8) develop an aquatic plant management plan; and 9) complete sewer system installation for the entire lake.

3.0 STORM DRAIN PROJECT REVIEW

3.1 Site Descriptions and Alternatives

The project area includes land drained by town-regulated storm drains to the east of State Road 13 in North Webster. The estimated watershed area contributing to the storm drains is about 200 acres (80 ha or 0.32 miles) although since a detailed drainage study was not conducted as part of this study, this acreage is only an estimation, and the contributing watershed could actually be larger.

The area of the watershed draining directly to the lake on its west side is currently high intensity residential and commercial development. State Road 13, a busy, state-maintained highway, passes through North Webster's downtown and receives heavy sand and gravel applications during the winter. The Town of North Webster is responsible for maintenance of the other roadways within incorporated town limits. Litter from these commercial and transportation areas also finds its way into storm drains. Residential runoff carries yard waste, fertilizers, and other debris to the lake via the drains.

Town maps were modified and updated to include 18 drainage networks (Figure 1). Parts of the drainage infrastructure are old (Figure 5), but most of the older and newer drains are fitted with typical box drop structures also known as catch basins (Figure 6). Although it was beyond scope of the current study, some of the drain networks may require updating and resizing as development continues in the town and its watershed.

FIGURE 5. Drainage infrastructure example.

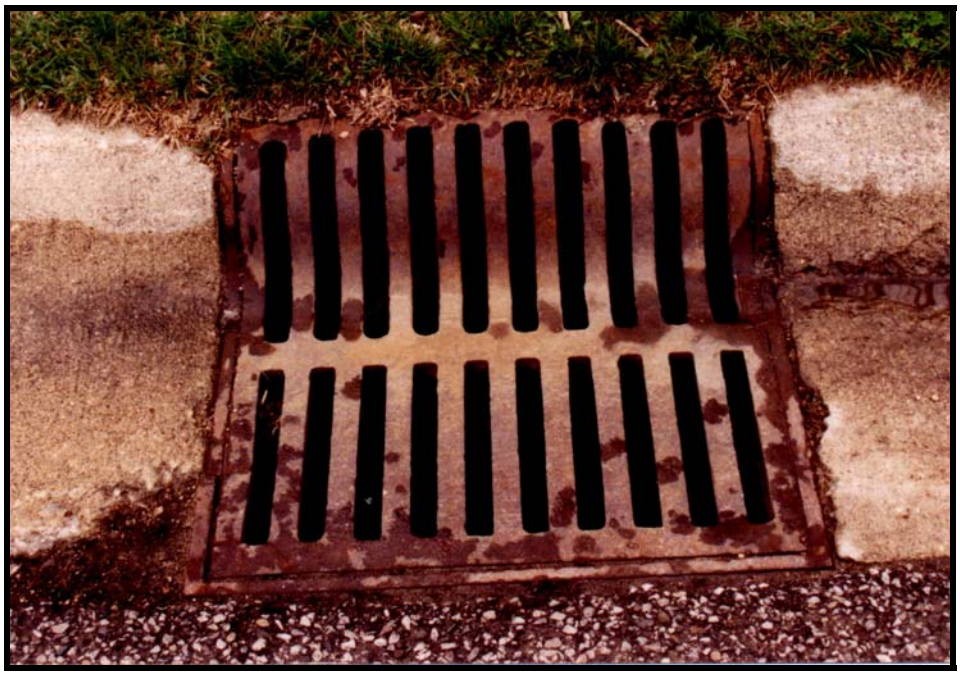

FIGURE 6. Catch basin example.

The most obvious problem observed during the feasibility study was lack of maintenance of the existing structures. As Figures 7-13 show, many of the structures were full, nearly full, or clogged with sand, gravel, lawn litter, trash, and other debris. Current research indicates that when sediment and debris fill more than 60% of the catch basin volume, the basin reaches "steady state" meaning that the basin no longer removes sediment from storm water runoff (Pitt and Bissonnette, 1984). Storm flows re-suspend sediments in the basin and pass them through the system. Based on the condition of the drains observed during the study, it is not surprising that lake residents have noted filling of channels with sand and gravel and the presence of trash, yard waste, and dead animals in the drains and in the lake. Additionally, some poor management practices were noted during the study like a snow pile that had been shoveled from a parking lot and deposited on a slope three feet above a drain inlet on Washington Street (Figure 11).

FIGURE 7. Catch basin on storm drain network #3.

FIGURE 8. Catch basin on storm drain network #4.

FIGURE 9. Catch basin on storm drain network #7.

FIGURE 10. Catch basin on storm drain network #14.

FIGURE 11. Catch basin on storm drain network #12.

FIGURE 12. Catch basin on storm drain network #13.

FIGURE 13. Catch basin on storm drain network #14.

Field surveys of the storm drains indicated that the current drain structure and/or maintenance schedule was not sufficient to protect Webster Lake water quality. Alternatives considered for remedying the existing situation included: 1) adopt a rigorous maintenance plan to ensure that the existing infrastructure performs as intended; 2) install two or three expensive "swirl collector style" Continuous Deflective Separation systems or other similar manufactured product for storm water inlets at the bottom of the highest priority drainage networks; 3) tear out the existing infrastructure at the base of the highest priority drainage networks and install sand filters, water quality inlets (also commonly called oil/grit or oil/water separators), or similar underground chamber device; 4) retrofit existing storm drain inlets with disposable, replaceable, inexpensive catch basin inserts like the Stream Guard sediment insert. Due to financial and other resource constraints, JFNew, the WLCA, and the Town of North Webster decided that the most feasible option is a combination of items one and four above. None of the options will be effective without regular inspection and maintenance. The Town of North Webster has hired Severn Trent Services to provide utilities maintenance, and the Town Council agrees that storm drain maintenance is an important service that should be provided. Once a regular maintenance plan has been implemented, it is recommended that drains be retrofitted with economical catch basin inserts if an evaluation deems the devices necessary and cost-effective for lake quality protection.

3.2 Easement and Land Availability Determination

The Town of North Webster has jurisdiction over drainage infrastructure within town-incorporated limits. The Town through its utilities contractor is responsible for maintaining drains and ensuring road safety within the town. At the August Town Council meeting, JFNew and WLCA presented study results to the council. The Town Council supports having their utilities contractor adopt a regular drain maintenance and cleaning schedule. If deemed necessary and cost-effective, the Town Council would support retrofitting of drains with pollutant filtration devices. At the September Town Council meeting, the council will sign the letter of support that appears in Appendix A.

3.3 Preliminary Design and Conceptual Drawings

Regardless of the general land use, some amount of any given pollutant may be carried away in runoff. However, some pollutant types are generally associated with different urban land use categories. Table 3 presents this information. Most of the feasibility study watershed consists of high density residential and commercial land uses with some gas stations and parking lots present as well. This land use information, along with input from lake residents and feasibility study observations indicate that storm water pollutants of greatest concern from North Webster include human trash, vegetation/organic debris, coarse and fine sediments, and a small amount of petroleum hydrocarbons. (Dissolved constituents like phosphorus and nitrogen are probably also a problem, although these parameters have not been sampled from these drains.)

TABLE 3. Pollutant types generally associated with urban land use categories. The table was adapted from Kristar Corporation, 2002.

Land Use	Pollutants					
	Human Trash	Vegetation/ Organics	Coarse Sediments	Fine Sediments	Petroleum Hydrocarbons	Cooking Oils and Fats
Low Density Residential	X	X	X			
High Density Residential	X	X		X		
Commercial	X			X		
Industrial	X			X	X	
Fast Food/ Restaurants	X					X
Gas Stations, Car Washes	X		X	X	X	
Parking Lots	X		X	X	X	

Based on information collected during this study, the most feasible alternative for improving North Webster storm drain performance includes a regular maintenance program and retrofitting drain inlets and catch basins with pollutant filtration inserts. Catch basins are intended for use as

pre-treatment for other treatment practices because they capture only large sediments and debris (EPA, 2002). An effective storm water treatment system integrates source controls, in-line controls, and end-of-the-pipe practices (Kristar Corporation, 2002). In North Webster, catch basins currently offer the only treatment for storm water. Since many of the basins were full to nearly full, they probably have been providing little, if any, treatment for many years. In fact, many of them have probably been acting as pollutant sources since storm water re-suspends the top materials and carries them with it to the lake. The installation of "end-of-the-pipe" practices (like water quality inlets or sand filters) on-line nearer the lake was considered during this study; however, due to limited accessibility to potential treatment sites, expense, and more demanding maintenance needs, these practices were not deemed feasible at this time. It follows that the most feasible treatment alternative, given the existing constraints, would involve controlling pollution sources before they enter the drainage system and then treating the runoff within the existing infrastructure.

Catch basin inserts have been used with success in many areas of the country (Pitt et al., 2000; Aronson et al., 1983; Mineart and Singh, 1994; Port of Seattle, 1998) including Plymouth, Indiana (Bright, 2002). There are many varieties and models that are commercially available, and depending on the insert model, it may remove litter, vegetation, oils and grease, and medium to coarse sediment. As noted above, many of these pollutants are problematic in storm water from North Webster. Inserts have been shown to be ineffective at capturing pesticides, herbicides, toxic chemicals, and dissolved material including dissolved nutrients (Kristar Corporation, 2002).

All storm water treatment technologies have advantages and disadvantages which is why the most efficient systems utilize several practices in the form of a "treatment train". Advantages of catch basins and inserts include: 1) relatively inexpensive cost; 2) effectiveness at removing larger debris and sediment; 3) space efficiency; 4) relative ease of installation. Disadvantages also exist: 1) catch basins remove pollutants at lower rates than structural practices like wet ponds, sand filters, or wetlands (EPA, 2002); 2) if not properly maintained, catch basins can act as pollutant sources; 3) as already mentioned, catch basins do not effectively capture soluble and fine-sized particles which can be of great concern for lake ecosystems.

Based on the above information, a regular maintenance schedule and catch basin insert technology similar to StreamGuard manufactured by Bowhead Manufacturing in Seattle, Washington are recommended for North Webster storm drains. The importance of a maintenance plan cannot be overstressed. No technology will properly function without maintenance. Because the town has never implemented a maintenance plan before, it is recommended that all catch basins be cleaned initially. At six-month intervals, all drains should be inspected and cleaned if necessary. After the maintenance plan has been in place for some time, town officials and their maintenance subcontractor should know which drains require more frequent inspection and maintenance. Available literature notes that catch basins should be cleaned once or twice per year (Aronson et al., 1993). Aside from maintenance, it is also recommended that StreamGuard oil and grease inserts be installed in North Webster catch basins. The oil and grease insert is effective at trapping trash, medium to coarse sediment, and hydrocarbons. The inserts are constructed of geotextile fabric that absorbs oil and captures trash and sediment (Figure 14). A filter pack within the unit absorbs floating oil and grease.

StreamGuard filters have several advantage over other brands and models including: 1) they target pollutants of concern in the North Webster area; 2) they are relatively inexpensive (See Section 3.7 for an opinion of probable annual cost.); 3) they have been used with third-party documented success in northern Indiana (Bright, 2002); 4) they are landfill disposable; 5) they are easily installed within catch basins and do not require physical re-engineering of the basin. It is also recommended that each catch basin be fitted with a hood to prevent larger trash and debris from entering the drain network.

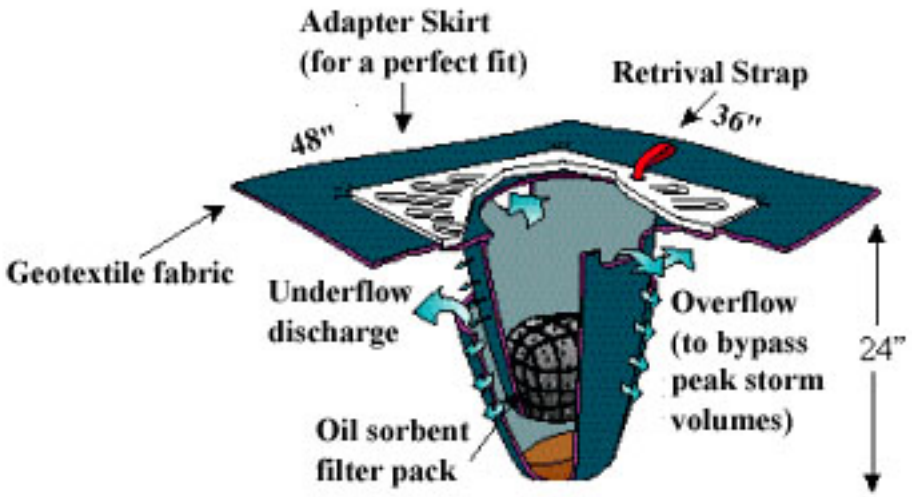

FIGURE 14. StreamGuard oil and grease insert conceptual diagram.

3.4 Permit Requirements

Because drain maintenance and retrofitting will not occur within designated "waters of the United States", state and federal permits typically required for lake protection projects are not necessary for this project. Proper drain function and maintenance in this case fall within the jurisdiction of the Town of North Webster. The governing body in North Webster, the Town Council, approves town utilities maintenance, and their approval is necessary for drain improvement projects like the type suggested in this study.

During the study, town approval for the project was sought. Early in the study, JFNew met with a WLCA representative and Marshall Minnick who was the utilities superintendent at that time in order to garner support for a storm water treatment project. Since that time, Mr. Minnick has resigned his position, and Severn Trent Services (STS) currently performs utilities activities under contract with the town. Prior to his resignation, Mr. Minnick communicated his and the town's support for a project that would address storm water quality. At the August Town Council meeting, JFNew, TELWF, and WLCA presented the study results to the Town Council, STS, and other meeting attendees. The town council is supportive of the project and will sign the letter that appears in Appendix A at their September meeting. STS will also sign the letter acknowledging the need for maintenance and possible retrofitting.

WLCA approval of project plans was also sought during the study since the association will be responsible for project progress in the future. In June, JFNew presented study results to the

WLCA in order to gage lake resident support for the project. Most of the members were interested in the study and supportive of storm drain treatment efforts; however, some members voiced other concerns as being of higher priority including: 1) aquatic plant infestations; 2) completion of sewer installation for the entire lake; 3) dredging; 4) lack of shoreline maintenance by other property owners; and 5) storm drain projects outside the town-incorporated limits.

3.5 Environmental Impact Assessment

As already discussed, storm drain maintenance, catch basin insert technology, and drain hoods have been recommended for storm drain networks within the Town of North Webster incorporated limits. Environmental considerations relevant to many water quality projects include the impact of such projects on wetlands, endangered, threatened, and rare (ETR) species, water quality, flooding, stream habitat, and stream biota. Since project-related work would occur within concrete catch basins surrounded by pavement, it is assumed that impacts to wetlands, ETR species, stream habitat, and stream biota would be non-existent. Impacts to water quality can only be positive given the condition of the drains during study inspections. As already noted, full catch basins reach steady state and can actually become pollutant sources. Based on the volumes of material at storm drain outlets in the lake, the Town of North Webster storm drains have not been effectively removing pollutants and have been adversely affecting water quality for many years. The recommended catch basin inserts and maintenance plan are not expected to increase the likelihood of flooding in the area drained by existing storm water inlets. StreamGuard catch basin inserts are constructed with overflow notches (Figure 14) to bypass peak storm volumes and prevent flooding. Drainage will actually be improved once a regular maintenance plan is in place. The recommendations will not increase flooding downstream of the storm drain inlets either.

3.6 Unusual Physical and Social Costs

The initial cleaning of the drains may present a potential, unusual physical cost as many catch basin grates have been cemented into place during street resurfacing projects. It is not known at this time if the grates can be removed without damaging the road surfaces. Social costs associated with the project involve maintenance expenses. Environmental Protection Agency (EPA) literature sites the “true cost” associated with catch basins as “long term maintenance” (EPA, 2002). These costs are not truly “unusual” as any properly functioning system requires maintenance. Maintenance expenses will likely be passed on to town residents and may be viewed as an unnecessary burden by some. A comprehensive maintenance program would include: inspection, updating an inspection log, cleaning as necessary, replacing inserts as necessary, and disposing of removed material. Instituting the program would require: personnel hours, trained personnel, and proper equipment (like a vactor truck). Costs associated with proper maintenance are certainly not insignificant.

3.7 Prioritization, Opinions of Probable Cost, and Proposed Time Line

Because resources are limited and because there are 18 storm drain networks, JFNew prioritized the networks for treatment based on watershed observation, consideration of storm water volumes conducted by each network, input from lake residents, runoff event observation, and estimation of pollutant loading severity. Table 4 and Figure 15 summarize the prioritization. (The same disclaimer mentioned earlier regarding Center Street and Albert Eckert Drive also applies to this figure.) Appendix B contains detailed summary information for each of the storm

drains networks compiled during reconnaissance tours on April 9 and 12. It is important to note that BMPs relevant for treatment of drain network #1 do not involve retrofitting technologies. Additionally at this time, no actions are recommended for drain network #5 other than regular sediment basin maintenance which is the responsibility of the property owner at the site. Since retrofitting technologies do not apply to these drains, they are not included in the prioritization.

TABLE 4. Storm drain network prioritization.

Drain	Priority	Drain Network Description	Recommended Project
#4	High	3-basin complex draining southern bend of Albert Eckert Drive	Maintain and retrofit catch basins a, b, and c; it was noted that water bypasses catch basin c almost completely and travels over the road to the lake
#6	High	7-basin complex draining Panorama and Epworth Forest Roads	Maintain and retrofit catch basins a-g
#9	High	8-basin complex draining North Street from SR 13	Maintain and retrofit catch basins a-h
#12	High	2-basin complex draining the Washington Street area	Maintain and retrofit catch basins a and b
#14	High	8-basin complex draining South and Mulberry Streets	Maintain and retrofit catch basins a-h
#15	High	3-basin complex draining Mulberry Street	Maintain and retrofit catch basins a, b, and c
#2	Medium	2-basin and open ditch complex draining Hoss Hill and Epworth Forest Roads	Maintain and retrofit catch basins a and b
#3	Medium	Basin draining an area of Center Street East and West	Maintain and retrofit inlet catch basin
#7	Medium	Basin draining 3rd and 4th Streets	Maintain and retrofit inlet catch basin
#8	Medium	Series of basins, culverts, and open swales draining SR 13 and a graveled trailer park area	Maintain and retrofit catch basin b
#10	Medium	4-basin complex draining Stanley Street	Maintain and retrofit catch basins a-d
#11	Medium	4-basin complex draining Short Street	Maintain and retrofit catch basins b and c
#13	Medium	6-basin complex draining an island and portion of South Street	Maintain and retrofit catch basins a-f
#16	Medium	6-basin complex draining a portion of Mulberry Street	Maintain and retrofit catch basins a-f
#17	Low	2-basin complex draining Effie May Street	Maintain and retrofit catch basins a and b
#18	Low	3-basin complex draining Boydston Drive	Maintain and retrofit catch basins a and b

J.F. New & Associates, Inc.
JFNA #98-04-25/02

North Webster Storm Drain Engineering Feasibility Study
Kosciusko County, Indiana

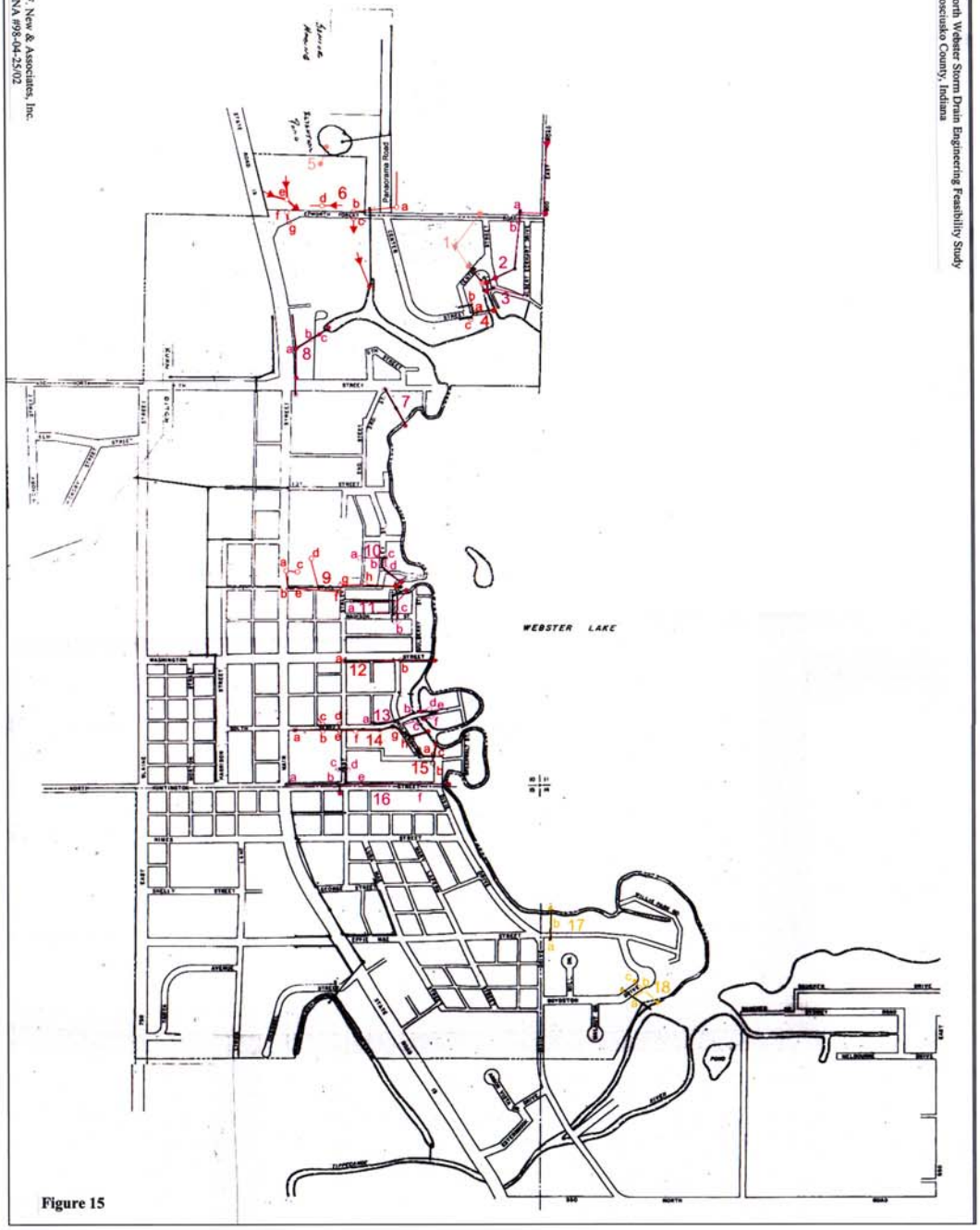

Figure 15

LEGEND

- NO PROJECT RECOMMENDED
- LOW PRIORITY
- MEDIUM PRIORITY
- HIGH PRIORITY

TOWN OF
NORTH WEBSTER, INDIANA
STREET MAP

0 600
GRAPHIC SCALE IN FEET

October 29, 2002

The following tables outline opinions of probable cost based on priority classification. Table 5 includes annual cost estimates for catch basin maintenance only. Table 6 gives annual cost estimates for purchase of catch basin insert materials, and Table 7 details cost estimates for maintenance if insert technology is utilized. Considering both maintenance and insert costs, a comprehensive catch basin maintenance and filtration program would cost the Town approximately $15,000 per year. It is important to note that these opinions of probable cost are based on some assumptions. Additionally, costs may vary since some drains may require more frequent maintenance than others. These are estimates only and may not reflect actual cost.

TABLE 5. Opinions of probable cost for catch basin maintenance.

Item	Cost	Number	Total
Utility personnel	$20/hour for an 8-hour day for 4 days	2	$1280
Cleanings per year	$1000*	2	$2000
Disposal of material	$500**	2	$1000
Utility personnel training	$500†	1	$500
Annual Maintenance Cost			**$4780**

*Reflects estimated cost for operation and maintenance of a vactor truck.
**This estimate could be highly variable depending on availability of disposal areas.
†This estimate could be highly variable depending on personnel turn over.

TABLE 6. Opinions of probable cost for StreamGuard oil and grease catch basin inserts.

Treatment	Cost per Unit	Units Needed	Annual Replacement Rate	Total Cost
High priority catch basins	$82.00	31	2	$5084
Medium priority catch basins	$82.00	23	2	$3772
Low priority catch basins	$82.00	4	2	$656
All catch basins	**$82.00**	**58**	**2**	**$9512**

Cost estimates are based on an April 2002 quote from Jeff Bird of Bowhead Manufacturing at 1-800-909-3677 ext. 5237 or at birdjm@bowhead.com.

TABLE 7. Opinions of probable cost for catch basin and insert technology maintenance.

Item	Cost	Number	Total
Utility personnel	$20/hour for an 8-hour day for 6 days	2	$1920
Cleanings per year	$1000*	2	$2000
Disposal of material	$500**	2	$1000
Utility personnel training	$500†	1	$500
Annual Maintenance Cost			**$5420**

*Reflects estimated cost for operation and maintenance of a vactor truck.
**This estimate could be highly variable depending on availability of disposal areas.
†This estimate could also be highly variable depending on personnel turn over.

Table 8 provides the recommended project timeline. Obviously, the sooner action is taken, the greater the benefit will be to the lake, especially if a maintenance program can be started before winter weather conditions require roadway application of sand, gravel, and salt. In a limited number of cases, engineering and design issues may need to be considered if removal of the

grate structure could damage the road or if the particular catch basin is not currently configured to properly hold an insert device.

TABLE 8. Recommended project timeline for catch basin maintenance and retrofitting.

Time	Activity
Fall of 2002	Initial removal of grates and cleaning of catch basins.
Spring of 2003	Second inspection and cleaning of catch basins.
Fall of 2003	Third inspection and cleaning of catch basins. After inspection, the town council, WLCA, and STS will need to decide whether or not to install insert technology.
Every spring and fall thereafter	Inspection and cleaning of catch basins and changing of catch basin inserts if retrofits are installed.

3.8 Project Justification and Estimation of Impact

Justification for the maintenance project is simply that no infrastructure or technology will properly function without it. Based on observations made during the study, storm drains have not received maintenance nor have they properly functioned in many years. As already stated, lake residents complain about refuse carried to the lake via the drains and about filling of channel areas with sediment and debris. If catch basins (especially the high priority ones) could be fitted with insert filtration technology, runoff water quality would be the best it could be short of building expensive, space-consumptive "treatment trains". Catch basin inserts are the most cost-effective, readily available, and most feasible treatment alternative at this time.

Because most of the storm drain systems in the study area only actively transport water while it is raining and because many of the storm drain outlets to the lake are completely plugged with sediment and other debris, it was impossible (and beyond the scope of this study) to sample all 18 network outlets to determine pollutant loading rates. JFNew was able to collect samples at three drain inlets for discharge, total suspended solids (TSS), and total phosphorus (TP) following a storm event that dropped about 1.1 inches of rain in the area (Table 9). Chris France at the North Webster Sewage Treatment Plant graciously analyzed the samples at no charge.

TABLE 9. Discharge and chemical data collected at the drain outlets of networks #1, #2, and #6 following a rain event on April 9, 2002.

Drain	Discharge (cfs)	TSS Conc. (mg/l)	TSS Load (kg/day)	TP Conc. (mg/l)	TP Load (kg/day)
1	1.30	39.7	126.2	0.15	0.48
2	0.89	50.3	109.6	0.19	0.41
6	1.90	26.3	122.3	0.22	1.02

The results in Table 9 along with data taken from the literature can be used to estimate potential reductions in pollutant loading. Properly maintained catch basins have been found to remove 32-97% of TSS (Pitt et al., 2000 and Mineart and Singh, 1994). Coupling catch basins with filtration inserts can result in further sediment loading reduction of 70-80% (Port of Seattle, 1998). Bright (2002) reported that sediment loading from the town of Plymouth to the Yellow River could be reduced by 20 tons per year based on collected data. Some general assumptions about precipitation and loading, literature values, and data in Table 9 provide an estimation that

North Webster sediment loading to the lake could be reduced by as much as 69 tons per year at a cost of $0.11 per pound. (The assumptions and spreadsheet used to calculate this value appear in Appendix C.) Although few studies have looked at catch basin and catch basin insert ability to reduce total phosphorus loads, it is expected that at the very minimum, the particulate fraction of phosphorus bound to medium and coarse-grained sediments would be retained in the basin and insert. Although no oil and grease measurements were taken during the current study, the Port of Seattle (1998) and Bright (2002) reported removal rates of 93% and 75-95% respectively.

4.0 RECOMMENDATIONS

1) The WLCA should continue to work with the Town Council to ensure that a storm drain inspection and maintenance plan is implemented in the fall of 2002. The Town Council and STS should be supportive of these efforts.
2) In the fall of 2003, the WLCA should work with the Town Council and STS to determine if drain retrofitting is desirable given available resources. Depending on available resources, WLCA should consider retrofitting at least the high priority networks.
3) The WLCA should continue to seek funding for storm water runoff treatment projects in order to help the Town Council meet the goal of adopting a comprehensive storm drain maintenance and filtration program.
4) The WLCA should have a representative present at monthly town council meetings to ensure better long-term communication regarding this project and other lake conservation projects.
5) The WLCA should initiate an information and education program to inform town and lake residents about practices they can utilize to control sources of pollutants and debris before they are introduced into the storm drain system. Some of these source controls could include: not littering, routing runoff water away from sand and gravel areas, using grassy swales as part of the lawn-scape to filter runoff before it reaches drains, cleaning up lawn waste and other debris, utilizing lawn fertilization buffer strips (fertilizer-free zones) near storm drains, and not pouring foreign materials into catch basins.

5.0 FUNDING SOURCES

The following section lists funding sources that may be available for use in implementing a comprehensive storm drain maintenance and filtration plan. The list may not be all-inclusive, but every attempt has been made to include sources that may be relevant for projects of this type.

Town of North Webster
The Town Council of North Webster has acknowledged that storm drain maintenance is necessary to ensure proper drainage and to protect lake water quality. The town council is supportive of integrating storm drain management into regular utilities functions performed by its contractor, STS. Use of utility tax dollars administered through the Town Council should be maximized with some of those dollars used for or directed toward storm water management.

Lake and River Enhancement Program (LARE)
This is the program that funded this feasibility study. The Indiana Department of Natural Resources, Division of Soil Conservation administers the LARE Program. The program's main goals are to control sediment and nutrient inputs to lakes and streams and prevent or reverse degradation from these inputs through the implementation of corrective measures. Under its current policy, the LARE program may fund lake and watershed specific construction actions up to $100,000 for a specific project or $300,000 for all projects on a specific lake or stream. Cost-share approved projects require a 0-25% cash or in-kind match, depending on the project. LARE also has a "watershed land treatment" component that can provide grants to SWCDs for multi-year projects. The funds are available on a cost-sharing basis with landowners who implement various BMPs.

Clean Water Act Section 319 Nonpoint Source Pollution Management Grant
The Indiana Department of Environmental Management (IDEM), Office of Water Management, Watershed Management Section administers the 319 Grant Program. 319 is a federal grant made available by the Environmental Protection Agency (EPA). 319 grants fund projects that target nonpoint source water pollution. Nonpoint source (NPS) pollution refers to pollution originating from general sources rather than specific discharge points (Olem and Flock, 1990). Sediment, animal and human waste, nutrients, pesticides, and other chemicals resulting from land use activities such as mining, farming, logging, construction, and septic fields are considered NPS pollution. According to the EPA, NPS pollution is the number one contributor to water pollution in the United States. To qualify for funding, the water body must be: listed in the state's 305(b) report as a high priority water body, listed on the state's 303(d) list as impaired due to a nonpoint source pollutant, noted as impaired by NPS pollution in Indiana Clean Lakes Program reports, documented in the Unified Watershed Assessment for Indiana report as impacted by NPS pollution, or be identified by any other documentation as being NPS pollution affected. Funds up to $300,000 can be requested for individual projects. There is a 25% cash or in-kind match requirement.

Section 205(j) Water Quality Management Planning Grants
Funds allocated by Section 205(j) of the Clean Water Act are granted for water quality management planning and design. Grants are given to municipal governments, county governments, regional planning commissions, and other public organizations for researching

point and non-point source pollution problems and developing plans to deal with the problems. According to the IDEM Office of Water Quality website: "The Section 205(j) program provides for projects that gather and map information on non-point and point source water pollution, develop recommendations for increasing the involvement of environmental and civic organizations in watershed planning and implementation activities, and implement watershed management plans. No match is required. The IDEM website http://www.in.gov/idem/water/planbr/wsm/Section205j_main.html provides more information on the Section 319 and 205(j) grant opportunities.

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APPENDIX A

Town Council Letter of Support

NORTH WEBSTER STORM DRAIN
ENGINEERING FEASIBILITY STUDY
KOSCIUSKO COUNTY, INDIANA

J.F. New & Associates
ecological consultants & environmental engineers

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Walkerton, Indiana 46574
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Native Plant Nursery:
Walkerton, Indiana

www.jfnew.com

Wise Growth
Through Stewardship

August 27, 2002

Kay Andrews
North Webster Town Council
144 S. Main Street
North Webster, Indiana 46555

Re: Acknowledgement of Storm Drain Maintenance and Retrofitting

Dear Kay Andrews and North Webster Town Council:

J.F. New & Associates, Inc. is conducting the Lake Webster Storm Drain Engineering Study for the Lake Webster Conservation Association with funding from the Indiana Department of Natural Resources Lake and River Enhancement (LARE) Program. Town-regulated storm drains were noted during the 2000 LARE Lake Webster Diagnostic Study as a potential pollutant source to the lake, and the study recommended retrofitting the drains with pollutant removal devices and developing an inspection and maintenance plan for these devices.

Upon our inspection of the drains during the feasibility study, it was clear that drain maintenance was rarely, if ever, performed. Our study will recommend a regular inspection and maintenance plan for existing town-regulated drains and will recommend that the town support installation of pollutant filtering devices should they be deemed necessary once the regular maintenance program is in place. Obviously, storm water runoff to the lake would be of higher quality if pollutant removal devices were installed and properly maintained.

Please sign and have your utilities contractor Severn Trent sign the bottom of this letter acknowledging that during the study drain maintenance was brought to the attention of the Town Council and its contractor at the August 14, 2002 Town Council meeting. By signing, you also acknowledge that the study will recommend retrofitting the drains with economical pollutant removal devices if an evaluation conducted after the maintenance program has been implemented deems the devices necessary and cost-efficient for protection of lake quality.

We appreciate the Town Council's willingness to work with the Lake Webster Conservation Association to protect and improve lake water quality. Should you have any questions regarding this letter or the study, please don't hesitate to give Lynn Stevens or me a call at (574) 834-3242 or (574) 586-3400 respectively. We hope to be providing the Town Council with a copy of the study within the next couple weeks. Thank you for your time and attention to this matter.

Best Regards,
Cornelia L. Sawatzky
Cornelia L. Sawatzky

We acknowledge that we are aware that storm drain maintenance is essential to proper drain function and protection of lake water quality. We also acknowledge that the Webster Lake Conservation Association may be interested in retrofitting the existing drains in the future if deemed cost-effective.

North Webster Town Council representative

Dennis Rasmussen
Severn Trent Services, Utilities Manager

APPENDIX B

Detailed Summary Information Taken from Field Notes for Each Storm Drain Network

NORTH WEBSTER STORM DRAIN
ENGINEERING FEASIBILITY STUDY
KOSCIUSKO COUNTY, INDIANA

North Webster Storm Drain Tour
Lynn Stevens and Cornelia Sawatzky
April 9 and 12, 2002

Drain Network #1: DESCRIPTION: This drain network starts as a 10" open metal culvert of the north side of Epworth Forest Road. The pipe runs underground 160 feet in a southwest direction and is actually broken in two places in the residential area. During storms, water fills the pipe and comes to the surface to run over the top of the ground. It was noted that the pipe is rusted out in many places. Water from the pipe and from surface runoff due to the broken pipe form an open swale or ditch. See labeled photos #1, 2, 3, and 4. The small ditch crosses under Center Street through a culvert into a pipe which discharges into the lake. The stream runs continuously regardless of storm flow, but the source of water to the network is unknown. Drainage is from underground tiling of yards and residential housing. No drainage is directly tiled to this stream from Epworth Forest Road because there are no catch basins or inlets on the road. **WATERSHED:** The watershed is composed of residential property near the lake, parts of the Tri-County Fish and Wildlife Area that include Shock Lake, tiles from Bart Culver's land which is not currently farmed but a portion of which has been donated for more senior housing, some agricultural land, and some natural springs. This network does not receive any runoff from SR13, but it does receive inputs from CR800E and Epworth Forest Road. **SAMPLING:** A water sample was collected at the drain outlet to the lake at 9:47am for analysis of TP and TSS. The bottle was labeled 1. The temperature was 8°C and DO was 10.3 mg/l. Discharge was 1.3 cfs. **RECOMMENDATION:** The open water channel should probably be tiled under the residential lawns to prevent erosion while encouraging property owners to use P-free fertilizers. Stormwater BMPs should be implemented as the senior housing is developed and agricultural BMPs implemented on land that is still used for production. The swale area where the stream now crosses the residential area should be planted with native vegetation to encourage both water and nutrient uptake from drainage in the swale area. A stormwater treatment device is not applicable in this situation.

Drain Network #2: DESCRIPTION: An open ditch runs along Hoss Hill Road into a culvert under Hoss Hill Road and then underground to a basin (a) where it crosses Epworth Forest Road to another basin (b) that is a street drain which adds more water to the network and conducts it to the open stream. The small stream crosses under the street in a culvert to a pipe that discharges into the lake. See labeled photos #5-10. There are times when the small stream is dry. One of the property owner in the area noted that one of other property owners of the land where the drain is an open stream installed a 12" underground tile so that he could have a level backyard. However, during larger storms, the 12" tile is overwhelmed, and runoff still passes over the surface through the property owner's yard. **WATERSHED:** The watershed is similar to that of Drain network #1 – residential, tiles from Bart Culver's land, agriculture, Epworth Forest Road, and Tri-County Fish and Wildlife Area. This network does not receive any runoff from SR13, but it does receive inputs from CR800E and Epworth Forest Road. **SAMPLING:** A water sample was collected at the inlet to the lake at 9:55am for analysis of TP and TSS. The bottle was labeled 2. The temperature was 6.5°C and DO was 11.2 mg/l. Discharge was 0.89 cfs. **RECOMMENDATION:** Catch basins a and b could potentially be fitted with stormwater filtration technology. This inlet is probably fine the way it is although if monies were available bank stabilization bioengineering techniques could improve the aesthetics of the stream and

prevent erosion which homeowners in the area have been trying to combat by rip-rapping the banks. Property owners should be encouraged to use P-free fertilizers, development should proceed with property stormwater management, and agricultural BMPs should be used on land where crops are still grown. A stormwater treatment device is not applicable in this situation.

Drain Network #3: DESCRIPTION: This short drain network consists of one inlet off of Center Street East conducting water under residential property to the lake. See labeled photos #11-12. The catch basin has not been maintained. There is evidence that gravel and sand from the road and trash, yard refuse, etc. frequently enter the catch basin and are conducted to the lake. The mouth of the pipe at lake level has been filled up with debris and was not visible. Property owners in the area noted that the street surfaces have not been sloped and configured properly to ensure that water is routed toward storm sewer drains and catch basins. This causes water to flow across residential yards and streets to the lake channel. **WATERSHED:** The watershed is entirely residential and residential streets. **SAMPLING:** No sample was collected as water only passes into the catch basin when it is raining. **RECOMMENDATION:** The catch basin that accepts water needs to be properly maintained and cleaned. The catch basin located on Center Street could be retrofitted with a stormwater inlet filtration device for pollutant removal.

Drain Network #4: DESCRIPTION: Network #4 is a 3-basin complex draining the southern bend of Albert Eckert Drive. See labeled photos 13-19. These catch basins have not been maintained either. The researcher believes that substantial sediment and sediment-related pollution introduction to the lake could be prevented if the catch basins were maintained. Of the 3-basin complex, basin b was completely clogged, and the drop structure at basin a was almost completely filled with sediment. There was also evidence of sand and gravel introduction to basin c from the road upslope. It was also noted during the study that water almost completely bypasses catch basin c and runs over the street to catch basin a and directly to the lake. The slope is not conducive to routing water catch basin c for filtration. **WATERSHED:** The watershed is entirely residential and residential streets. **SAMPLING:** No sample was collected as water only passes into the basins when it is raining. **RECOMMENDATION:** Catch basins a, b, and c of the 3-basin complex need to be properly maintained and cleaned. All three catch basins could be retrofitted with a stormwater inlet filtration device for pollutant removal. Of priority for filtration would be basins a, then b and c. Some pavement and curb reconfiguration and sloping is probably needed in this area to ensure effective drainage and storm water filtration although this recommendation is outside of the current study's scope.

Drain Network #5: DESCRIPTION: Drain network #5 drains water from the stormwater detention basin behind the senior housing to the wetland on the Moore property at the corner of SR13 and Epworth Forest Road which is no longer farmed. See labeled photos 20-23. The pond was full on April 9, 2002 and was spilling out of the pond overflow through a pipe toward the wetland. **WATERSHED:** The watershed is stormwater runoff from the senior housing. A concern is that the senior housing was recently expanded but the basin was not enlarged nor was a second basin constructed. **SAMPLING:** No sample was collected as outlet water passes to the wetland where it is retained for some unknown period of time prior to being conducted toward the lake. **RECOMMENDATION:** Since stormwater management practices are already installed here in the form of a sediment basin, no further recommendations are applicable at this

time. The Moore property was the focus of another feasibility study that has since been taken over by Sam St. Clair of the Kosciusko County SWCD.

Drain Network #6: DESCRIPTION: The drain #6 network is composed of a series of 7 catch basins (a-g). Water enters the system from the east via basin a that collects water from the church area and from Panorama Road (Photo 24). The drain passes under Panorama Road heading for the wetland. Somehow the water in this wetland is passed under Epworth Forest Road and the open field to the lake. Catch basins b and c are located on Epworth Forest Road and seem to pass water from the road under the open field to the lake (Photo 25). Catch basin d is in the agricultural field known as the Moore property (Photo 26) and seems to pass water toward basin e which is also in the agricultural field (Photo 27). Catch basin e seems to pass water diagonally toward the open field behind Adventureland Fun Park to the lake. Basins f and g are on Epworth Forest Road and seem to pass water to catch basin e (Photo 28). Water enters the lake via a large pipe. The water entering the lake was noticeably discolored (Photo 29). **WATERSHED:** The watershed is the senior housing detention basin, the Moore property, an industrial park, some ground that is still used for production, the Adventureland Fun Park, residential, Epworth Forest Road, some drainage from SR13, the Moore property wetland, and a swan-boat manufacturing business. **SAMPLING:** A water sample was collected at the network's outlet to the lake at 11:20am for analysis of TP and TSS. The bottle was labeled 3. The temperature was 7.5°C and DO was 9.5 mg/l. Discharge was 1.9 cfs. **RECOMMENDATION:** The Moore property was the focus of another feasibility study that has since been taken over by Sam St. Clair for wetland construction. Catch basins a-g near Epworth Road could potentially be fitted with stormwater inlet filtration devices to collect pollutants enter the catch basins; however, it is doubtful that this treatment would address the majority of the pollution problems in this area. Sand and gravel introduction to the catch basins was not observed to be a major problem making it difficult to prioritize the network for treatment.

Drain Network #7: DESCRIPTION: Drain network #7 accepts water from 3rd and 4th streets and conducts it via a 6" pipe to the lake. See labeled photos 30 and 31. The drop structure was almost completely filled in with sand and gravel. **WATERSHED:** The watershed is entirely residential and residential streets. **SAMPLING:** No sample was collected as water only passes into the network when it is raining. **RECOMMENDATION:** The catch basin that accepts water needs to be properly maintained and cleaned. The catch basin located at the intersection of 3rd and 4th Streets could be retrofitted with a stormwater inlet filtration device for pollutant removal.

Drain Network #8: DESCRIPTION: The drain #8 complex is actually two separate networks conducting water to the lake. The first of the two starts on SR13. A culvert conducts water north under 4th Street to an open swale (Photo 32). A concrete funnel to the north conducts water south via an open swale (Photo 33). This water comes together at Culvert a which is an old clay tile (Photos 34 and 35). An underground tile passes this water to the lake (Photo 36). The other complex drains only the trailer park and its gravel road. Two gutters conduct water to catch basin b (Photos 37-39) which passes the water to Culvert c which dumps water down some old concrete steps to the lake (Photo 40). During the tour a gentleman was fertilizing the fairly steep hillside up to the lake's edge. He had also fertilized the concrete steps. He said that during hard rains they don't get very good drainage, and the trailer park floods. **WATERSHED:** The watershed is primarily the gravel road through the mobile home park, the mobile home park, SR

13, and some urban development off of SR 13. **SAMPLING:** No sample was collected as water only passes into the networks when it is raining. **RECOMMENDATION:** Catch basin b could use a stormwater filtration device; however, a design phase would be necessary to determine if the basin could indeed be easily/cheaply fitted with the technology since the basin is not a standard set-up.

Drain Network #9: DESCRIPTION: This 8-basin complex drains North Street from SR13 to the lake. See labeled photos 41-49. Many of these catch basins were almost clogged with sediment. We were unable to locate the outlet of this network into the lake. There was evidence of sand, gravel, trash, and yard debris entering the catch basins especially at a, f, g, and h. Basins c and d were in the old deserted school parking lot, and not much debris was seen entering them. **WATERSHED:** The watershed is primarily North Street, SR13, and residential. **SAMPLING:** No sample was collected as water only passes into the network when it is raining. **RECOMMENDATION:** Basins a-h could all be fitted with stormwater filtration devices. Priority for treatment could include basin a since it is near SR 13 and c since there was significant evidence of sediment introduction to the basin. Other priority catch basins could include b, e, f, g, and h.

Drain Network #10: DESCRIPTION: This four-basin complex drains Stanley Street southeast to the lake. See labeled photos 50-53. Catch basin a is located in the back of the old parking lot at the deserted school. The remaining basins are located along Stanley Street. Lake residents have noted the channel area as a major problem – filling in, trash in channel, dead animals, etc. **WATERSHED:** The watershed is primarily Stanley Street and residential. **SAMPLING:** No sample was collected as water only passes into the network when it is raining. **RECOMMENDATION:** Catch basins a-d could all be fitted with stormwater filtration devices. Priority for treatment could include basin c since there was significant evidence of sediment introduction to the structure.

Drain Network #11: DESCRIPTION: Drain Network 11 is a four-basin complex draining mostly streets and residential areas to the lake at the Short Street dead end (Photos 54-57). **WATERSHED:** The watershed is residential streets and residential property. **SAMPLING:** No sample was collected as water only passes into the network when it is raining. **RECOMMENDATION:** Catch basin c could be fitted with a stormwater filtration device. Basin b also might be able to be easily fitted if the catch basin cover can be removed.

Drain Network #12: DESCRIPTION: This drain network takes water from Washington Street and surrounding areas to Lake Webster. The network has two catch basins along the south gutter of Washington Street (Photos 58-60) that conduct water to the lake (Photo 61). Above catch basin a, the city had been stacking snow mixed with gravel and sand which was running directly into the basin and eventually into the lake. Catch basin a had not been cleaned in quite some time. The north side of Washington Street is drained to the lake via a gutter (Photo 62) to the lake where there is evidence of sedimentation (Photo 63). Washington Street is generally a dirty street and should be cleaned more often (Photo 64). **WATERSHED:** The watershed is mostly Washington Street, some of the businesses on the east side of SR13, and some residential. **SAMPLING:** No sample was collected as water only passes into the network when it is raining.

RECOMMENDATION: Both catch basins a and b could be fitted with stormwater filtration devices, and based on the amount of trash and sediment, these two basins should be of priority.

Drain Network #13: DESCRIPTION: Drain network #13 is a six-drain complex. Three of the catch basins are on a small island with about 10 houses. Catch basins a-c drain the east end of south street to the lake. Photo 65 is catch basin b close to where the drain enters the lake near the bridge that crosses over to the island. Catch basins d-f drain the street and residential area on the small island (Photo 66). The area is quiet, doesn't receive much traffic, and is relatively clean. **WATERSHED:** The watershed is composed of streets and residential areas. **SAMPLING:** No sample was collected as water only passes into the network when it is raining. **RECOMMENDATION:** All 6 catch basins could potentially be fitted with stormwater filtration devices, but based on observations made during the tour, these basins should not be of top priority.

Drain Network #14: DESCRIPTION: Drain network #14 is an eight-basin complex draining South Street and Mulberry Road to the lake. See photos 67-70. **WATERSHED:** The watershed is SR13, South Street, Mulberry Street, and residential. **SAMPLING:** No sample was collected as water only passes into the network when it is raining. **RECOMMENDATION:** All 8 catch basins could potentially be fitted with stormwater filtration devices. Based on observations made during the tour, the order of priority should be a, b, g, f, and then h.

Drain Network #15: DESCRIPTION: Drain network #15 is a three-basin complex draining Mulberry Road to the lake. See photos 71-73. **WATERSHED:** The watershed is Mulberry Road and residential areas. **SAMPLING:** No sample was collected as water only passes into the network when it is raining. **RECOMMENDATION:** Catch basins a-c could all be fitted with stormwater filtration technology. Basin b would be of the highest priority.

Drain Network #16: DESCRIPTION: Drain network #16 is a 6-basin complex draining Huntington Street to the lake. See photos 74-77. **WATERSHED:** The watershed is SR13, Huntington Street, and surrounding residences and businesses. **SAMPLING:** No sample was collected as water only passes into the network when it is raining. **RECOMMENDATION:** Catch basins a-f could all be fitted with stormwater filtration technology. Basins a, d, and e would be of highest priority.

Drain Network #17: DESCRIPTION: Drain network #17 is a two-basin complex collecting runoff from Effie May Street and a residential lawn (Photo 78). **WATERSHED:** The watershed is Effie May Street and residential areas. **SAMPLING:** No sample was collected as water only passes into the network when it is raining. **RECOMMENDATION:** Catch basins a and b could both be fitted with stormwater filtration technology but are not of high priority since the area does not receive much traffic or sediment.

Drain Network #18: DESCRIPTION: Drain network #18 is a three-basin complex draining a small section of Boydston Drive and residential areas (Photos 79-81). We could not find the actual outlet to the lake. **WATERSHED:** The watershed is Boydston Drive and residential areas. **SAMPLING:** No sample was collected as water only passes into the network when it is raining. **RECOMMENDATION:** Catch basins a and b could potentially be fitted with

stormwater filtration but are not of high priority since the area does not receive much traffic or sediment. People in this area should be advised to use P-free fertilizer.

PRIORITIZATION:

No Filtration Recommended/Other Project Needed:

Basin #1
Basin #5

Low Priority:

Basin #17
Basin #18

Medium Priority:

Basin #2
Basin #3
Basin #7
Basin #8
Basin #10
Basin #11
Basin #13
Basin #16

High Priority:

Basin #4
Basin #6
Basin #9
Basin #12
Basin #14
Basin #15

APPENDIX C

Assumptions and Spreadsheet Used to Calculate Sediment Reduction Load

NORTH WEBSTER STORM DRAIN
ENGINEERING FEASIBILITY STUDY
KOSCIUSKO COUNTY, INDIANA

Assumptions Used to Calculate Sediment Reduction Load*

1. All drains load TSS to the lake during storms at comparable rates to the average rate at drains 1, 2, and 6 (119.4 kg/day) which were the only three drains sampled during the feasibility study.
2. The concentration and discharge at the time the sample was collected at each of the three drains is representative of the concentration and discharge during the entire day the drain was discharging.
3. If about 119.4 kg was loaded on the day North Webster received 1.1" of rain, then 3,786.1 kg would be loaded with the annual yearly average rainfall volume (34.88").
4. Loading occurs only during rain events.
5. If all drains load at rates comparable to drains 1, 2, and 6, then 18 drains would load 68,150 kg (or about 75 tons) over one year.
6. Catch basins remove TSS at a rate of about 65% which is the average taken from available literature (Pitt and Bissonnette, 1984; Mineart and Singh, 1994).
7. Catch basin inserts remove TSS at a rate of 75% above and beyond that of a catch basin alone (Port of Seattle, 1998).
8. Drain maintenance and retrofitting will cost about $14,932 annually.

*The author acknowledges that these are assumptions representing best estimations. Assumptions were necessary given the lack of data. These assumptions may or may not hold true should hard data be collected within the system.

Spreadsheet Used to Calculate Sediment Reduction Load

Drain	Parameter	Conc.	Conc. Units	Load	Load Units
1	TSS	39.7	mg/l	126.2	kg/day
1	TP	0.15	mg/l	0.48	kg/day
2	TSS	50.3	mg/l	109.6	kg/day
2	TP	0.19	mg/l	0.41	kg/day
6	TSS	26.3	mg/l	122.3	kg/day
6	TP	0.22	mg/l	1.02	kg/day

Avg. TSS Load (kg) received with 1.1" rain from one drain	119.4	**Avg. TSS Load (tons) received with 34.88" rain from 18 drains**	75.6	**Total annual cost**	14932.00
				Cost per pound	0.11
Avg. annual rainfall (in)	34.9	**Avg. TSS Load (tons) received with 34.88" rain from 18 drains with 65% reduction from catch basin**	26.5		
Avg. amount of rainfall remaining (in)	33.8				
Avg. TSS Load (kg) received with 34.88" rain from one drain	3786.1	**Avg. TSS Load (tons) received with 34.88" rain from 18 drains with additional 75% 65% reduction from catch basin**	6.6		
Avg. TSS Load (tons) received with 34.88" rain from one drain	4.2				
		Sediment Loading Reduction (tons)	69.0		